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(71)(72) Applicant and Inventor: LORIA, Roger, M. [US/US]; 3219 Brook Road, Richmond, VA 23227 (US).

(74) Agent: HENDRICKS, Glenna; 9669 A Main Street, Fairfax, VA 22031 (US).

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(54) Title: METHOD OF BALANCING OILS AND FATS TO ENHANCE HEALTH

(57) Abstract

The fatty acid balance of oils and fats used in the diet affects the cholesterol level in the blood serum. The balance of oils and fats which contain at least about 7 % saturated fatty acids and at least about 5 % linoleic acid is adjusted by adding an amount of α-linolenic acid equivalent selected from the group consisting of α-linolenic acid, ethyl linolenate and flaxseed oil to provide a food product wherein the α-linolenic acid content is 1 % to 10 % of the total fatty acid content of the oil or fat.

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METHOD OF BALANCING OILS AND FATS TO ENHANCE HEALTH

Field of the Invention:

This invention relates to methods of balancing fatty acids in fats and oils to enhance health.

Background of the Invention:

It is known that hypercholesterolemic mammals are more subject to cardiovascular and infectious disease conditions. Hence, it has been suggested that fats high in cholesterol should be replaced in the diet with fats low in cholesterol. However, several researchers have suggested that simply deleting cholesterol from the diet would not suffice as a means of lowering cholesterol. Garg, et al., discovered that the serum cholesterol level was higher in animals fed safflower oil than in animals fed saturated fat without fish oil. (Garg, et al., Biochimica et Biophysica Acta, 962:337-344, 1988)

It is known that infants under one year of age need linolenic acid in the diet. (See, for example, Nutrition Reviews, Vol 45, No. 8:232-234, Aug. 1987) Therefore, linolenic acid was added at a linoleic/linolenic ratio of 4/1 to 10/1. However, it has generally been stated that linolenic acid is not essential in the adult diet.

Dupont, et al (Journal of the American College of Nutrition, Vol 9: No. 5, (1990) 438-470) suggested that the use of corn oil to contribute to a polyunsaturated fatty acid intake of 10% in the diet would be beneficial to heart health. Dupont also suggested that no single source of salad or cooking oil provides an optimum fatty acid composition, but does not explain how to modify corn oil to render it balanced to provide a more nearly optimum fatty acid composition.

The adverse effect of increased serum cholesterol on immune response has long been known. (See Loria, et al.,

Journal of Infectious Diseases, Vol 133: No. 6, (1976) 655-662; Campbell, et al., Infection and Immunity, (July, 1982) 307-317) It is particularly important that hospital patients who are weakened and are exposed to infections prevalent in the hospital environment be protected from lowering of immune response that affects persons having a high serum cholesterol (hypercholesterolemia mediated immune suppression).

Turning to the patent literature, U.S. Patent 4,061,738 to Wayne Martin suggests administration of flaxseed oil (an oil that is high in linolenic acid) to avoid platelet aggregation with resultant thrombosis in coronary vessels. There is no suggestion that commonly used oils and fats can be rendered more health-inducing by addition of linolenic acid in accord with the teachings of the invention.

U.S. Patent 4,751,026 to Hoefle, et al. teaches that aniline-substituted oleic, linoleic, and linolenic acids may be used as medicinals to inhibit intestinal absorption of cholesterol. Hoefle does not suggest how to compensate for inadequate linolenic acid in cooking oils and fats. There is no teaching that unsubstituted α-linolenic acid alone would have beneficial effects on patients.

U.S. Patent 4,851,431 to Shlomo Yehuda suggests treating mammals with a composition comprising 13-27.5% linolenic acid with the balance of the composition being linoleic acid. That reference teaches that the composition induces memory enhancement in patients suffering from Alzheimer's disease.

U.S. Patent 4,948,811 to Spinner, et al. suggests that triglyceride cooking/salad oil compositions containing less than 3% of saturated fatty acids, 60-92% oleic acid, 5-25% linoleic acid, and 0-15% α-linolenic acid would be useful for lowering cholesterol. Spinner prepared his compositions from a mixture of "purified" fatty acids by converting the mixture to synthetic triglycerides. Spinner also teaches preparation of low-

saturated fatty acid oils by extraction of saturated triglycerides from canola oil and sunflower oil. Spinner does not teach how to modify commonly used oils and fats by simple mixing of readily available materials. Furthermore, that reference does not suggest addition of α-linolenic acid to nutritional supplements and parenteral feedings or administration of α-linolenic acid as a medicinal.

Summary of the Invention:

The present invention is directed to rendering inexpensive cooking oils from natural sources appropriate for maintaining appropriate serum levels of cholesterol. By the method of the invention, inexpensive oils such as corn, peanut and safflower oil can be balanced to provide health benefits by addition of α-linolenic acid as such or as an equivalent amount of combined α-linolenic acid such as a simple ester or as triglyceride contained in an α-linolenic acid-rich oil such as flaxseed or soybean oil (all hereinafter referred to as "α-linolenic acid") to provide a composition containing at least 1% linolenic acid, preferably at least 1.5% to 6% α-linolenic acid. The linolenic acid may be added as such or as a derivative such as an ester of linolenic acid with a non-toxic alcohol such as ethyl linolenate, or an appropriate amount of a linolenic acid-rich oil such as flaxseed (linseed) oil (47-48% linolenic acid) or even soybean oil (about 6.5% linolenic acid) to arrive at the desired α-linolenic acid content. Since soybean oil contains only about 6-7% α-linolenic acid, it is obvious that soybean oil cannot be used as an α-linolenic acid source when high concentrations of α-linolenic acid are desired. When augmented to contain about 3% α-linolenic acid the common oils such as corn oil or safflower oil are economical, palatable and nutritionally balanced to provide protection against hypercholesterolemia and excess total lipids. Partially hydrogenated oils used as margarine or cooking

or baking fats may retain significant amounts of monounsaturated (oleates and the like) and diunsaturated fats (linoleates), but the α-linolenic acid content (if any) of the original oil is generally removed by the hydrogenation. Such hydrogenated oils may have their α-linoleic acid content raised to the level required to control cholesterol by the method of the invention. The present invention also teaches use of α-linolenic acid as a medicinal or an addition to nutritional supplements or feedings for parenteral administration.

Detailed Description of the Invention:

This invention provides methods to balance inexpensive fats and oils to enhance health maintenance and to affect concentration of serum cholesterol in mammals who consume such oils and fats. The invention also provides a means of enhancing health by administration of α-linolenic acid as a medicinal and in nutritional supplements and parenteral feedings.

While much information on the effects of single nutrient components on cholesterol and other disease conditions associated with specific dietary lipids has been reported, a method of rendering fats and oils from economical sources more effective for preserving health is needed. It has now been found, surprisingly, that a diet high in animal fats is less damaging to health than a diet high in unsaturated fatty acids when the unsaturated fats contain an imbalance in the fatty acids. Addition of small amounts of α-linolenic acid as such or an equivalent amount of a derivative such as a simple ester or an appropriate amount of a high-linolenic acid oil such as linseed or soybean oil to fats and oils that are deficient in this lipid results in lowering of serum cholesterol. The amounts needed to provide the beneficial response are very small. Addition of α-linolenic acid to provide a concentration of as little as 1% α-linolenic acid/total lipids is sufficient to obtain significant improvement

drop in serum cholesterol. Moreover, it has been found that the concentrations of oleic acid and linoleic acid are not crucial to the maintenance of physiologically appropriate cholesterol levels in the blood and tissues so long as appropriate amounts of linolenic acid are available. Moreover, unlike the invention of U.S. Patent 4,948,811, the instant invention does not require that commonly used oils be treated remove saturated fatty acids or to contain a concentration of more than 60% oleic acid and less than 25% linoleic acid. Since most commonly available oils will not contain the amounts of oleic acid and linoleic acid required in the cooking/salad oil disclosed in the Spinner patent, the invention disclosed herein provides a much more economical means of balancing fatty acid intake to effect appropriate cholesterol levels.

The following chart gives the amounts of saturated acids, monounsaturated (usually oleic) acid, linoleic acid and linolenic acid in some of the commercially important oils:

Oil	Saturated Acids	Monounsaturated Acids	Linoleic Acid	Linolenic Acid
cocoa butter	59.8%	38.1%	2.1%	---
coconut	91.2%	7.9%	trace	---
corn	14.6%	51.1%	34.3%	---
cottonseed	27.2%	24.9%	47.8%	---
linseed (flaxseed oil)	9.5%	19.0%	24.1%	47.4%
olive	9.3%	84.4%	4.6%	---
palm	47.0%	42.7%	10.3%	---
peanut	18%	56%	26%	---
rapeseed (canola oil)	1%	82%	15%	1%
safflower	7.0%	17%	76%	trace
sesame	14.2%	45.4%	40.4%	---
soybean	13.4%	28.9%	50.7%	6.5%
sunflower seed	8.7%	25.1%	66.2%	---

(small amounts of other acids are present in minor amounts in some oils, therefore constituents do not add up to 100%)

It should be noted that all of the common oils listed above except rapeseed oil contain significant amounts (more than about 7%) of cholesterogenic saturated fatty acids. Also, all oils except cocoa butter and coconut oil contain significant concentrations (more than about 5%) of linoleic acid, which is associated with elevated cholesterol levels (Garg op. cit. and this work). Oils such as flaxseed oil which containing large amounts of linolenic acid often have a stronger taste than the more favored peanut, safflower, and corn oils. By the methods of the invention, it is possible to augment the oils more favored for cooking to provide necessary cholesterol-lowering α-linolenic acid without impairing the taste of the final product.

The use of linolenic acid to treat hypercholesterolemia has been studied in mice using three different diets.

EXAMPLES:

Materials and Methods:

Male C57BL\6J mice 6-7 weeks of age (Jackson Laboratories, Bar Harbor, Maine) weighing 19-23 grams were housed in groups of 4. Animals were kept in plastic cages with wood chip bedding, a filter bonnet cover, and tap water supplied ad libitum. Upon arrival, all mice were placed on a standard diet of Laboratory Rodent Chow #5001 (CHOW Ralston Purina, St. Louis, Missouri.). Within 7-8 days the mice were segregated into groups of 12 (4 per cage) and place on their respective diets:

(a) AIN76A *
(b) AIN76A + 1% cholesterol (AIN76A C)
(c) AIN76A + 1% cholesterol + 0.5% cholic acid (AIN76A CC)
(d) ANFAT **
(e) ANFAT + 1% cholesterol (ANFAT C)
(f) ANFAT + 1% cholesterol + 0.5% cholic acid (ANFAT CC)
(g) CHOW
(h) CHOW + 1% cholesterol (CHOW C)

(i) CHOW + 1% cholesterol + 0.5% cholic acid (CHOW CC)

* AIN76A is the American Institute of Nutrition 76A semipurified diet.

** ANFAT is semipurified high fat, sucrose diet.

Both AIN76A and the ANFAT diet have similar concentrations of sucrose and protein. The major differences between these diets, however, is that AIN76A contains 5% corn oil and 15% starch, while the ANFAT diet contains 18% lard as the source of fat, but contains no starch. The fatty acid analysis of corn oil and lard is presented in Table 1 while the total composition of the AIN76A and ANFAT diets are given in Table 2.

Animals were monitored daily and food was supplied ad libitum for an average of 10 to 12 weeks. Whole blood samples were obtained from the tail vein and plasma lipids were separated by thin layer chromatography as previously described. Quantitation was performed with a Bio Rad 620 Video Densitometer using corresponding reference lipids and internal standards.

Table 1

Composition of Corn oil, Lard and Chow fatty acid percent

	Corn Oil	Lard	Chow
Myristic (14)	1.0 ± 0.9	0.17 ± 0.7	1.73
Palmitic (16)	10.0 ± 2.0	19.3 ± 1.1	22.9
Stearic (18)	3.5 ± 1.0	23.2 ± 1.9	7.67
Palmitoleic (16:1)	0.9 ± 0.7	19.3 ± 0.9	1.91
Oleic (18:1)	34.0 ± 15.0	44.1 ± 3.6	32.4
Linoleic (18:2)	47.0 ± 13.0	6.7 ± 0.5	29.5
Linolenic (18:3)	---------	1.0 ± 0.6	3.07

Similar baseline lipid levels were obtained for each of the three diets (AIN76A, ANFAT and CHOW). There was no significant difference in the level of plasma free cholesterol ester, total cholesterol, and total plasma neutral lipid levels for animals fed these three diets. The plasma levels of free fatty acids (FFA) and triglycerides (TG) of animals fed the CHOW diet were 82 ± 11 and 61 ± 29, respectively. These were significantly

higher than the FFA and TG levels of animals fed AIN76A, whereas only the plasma TG level of the CHOW fed group was higher than the ANFAT diet fed group. In spite of the high animal fat content of ANFAT, neither the circulating plasma level of the individual neutral lipids nor the total neutral lipid level was higher than either the AIN76A or CHOW fed groups. This was significant because the ANFAT diet contains 18% lard, while AIN76A contains 5% corn oil and CHOW only includes 4.5% mixed animal and plant fats.

Table 2

Comparison of semipurified diets (% by weight)

	ANFAT	AIN76A
Casein	24.0	20.0
Lard	18.0	Corn Oil 5.0
Cholesterol	0	0
Cholic acid	0	0
Sucrose	52.6	50.0
Inositol	0.1	0
Choline Chloride	0.2	Choline bitartrate 0.2
Vitamin Mix	0.1	1.0
Salt	4.0	3.5
Cellulose	5.0	5.0
		Corn Starch 15.0
		dl methionine 0.3

Animals were then fed diets augmented with 1% cholesterol and 0.5% cholic acid. For animals fed CHOW and modified ANFAT diets containing 9%, 11%, and 13% lard, there was no significant increase in plasma neutral lipid levels. Furthermore, the addition of 1% cholesterol alone to AIN76A, ANFAT or CHOW did not result in significant change in plasma lipids. In contrast, addition of both 1% cholesterol and 0.5% cholic acid to AIN76A (AIN76A CC) and ANFAT (ANFAT CC) resulted in marked and statistically significant elevation of plasma neutral lipid levels. This elevation was limited to plasma cholesterol, cholesterol esters and total cholesterol in AIN76A CC-fed animals. The ANFAT CC group also displayed a significant

elevation in plasma FFA, but a decrease in TG levels.

Table 3

	Chol	ChEs	Total Chol	FFA	TG	Total lipid
AIN76A	62±9	177±18	168±20	49=2	17±7	309
AIN76A 1%Chol	41±14	137±36	123±42	48±15	25±14	251
AIN76A CC	111±20	309±50	296±53	64±10	25±14	507
ANFAT	71±8	176±19	176±53	30±12	40±11	317
ANFAT 1%Chol	61±5	155±17	153±21	17±6	34±9	267
ANFAT CC	113±19	292±35	288±42	59±11	17±4	478
CHOW	52±5	166±18	152±23	82±11	61±29	362
CHOW 1%Chol	44±7	148±20	133±26	67±12	14±9	273
CHOW CC	53±13	203±60	174±65	93±11	34±24	383

ANFAT-type diets prepared with 9, 11 or 13% lard do not exhibit the effects of added cholesterol and cholic acid seen with the standard (18% lard) diet
Definitions: Chol=Cholesterol, ChEs=Cholesterol ester, FFA=free fatty acids, TG=triglycerides, Total Chol=total cholesterol (Chol + ChEs x 0.59)

In view of this data, it was decided to add sufficient α-linolenic acid to approximate the amount in the CHOW. Therefore, sufficient α-linolenic acid was added to the ANFAT CC and to the AIN76A CC to provide 3% α-linolenic acid to total lipid in those diets. Such diets were identified as ANFAT CC/L and AIN76A CC/L. The addition of the α-linolenic acid to the AIN76A CC resulted in a drop of the serum lipid content. However, addition of the α-linolenic acid to the ANFAT CC did not result in significant decrease in serum lipids.

Table 4

	Chol	ChEs	Total Chol	FFA	TG	Total lipid
AIN76A CC	103±9	274±14	265±14	51±3	28±3	457
AIN76A CC/L	66±6	206±16	187±16	46±6	29±2	347
ANFAT CC	114±10	281±17	281±17	51±4	33±6	480
ANFAT CC/L	111±7	267±14	269±12	54±4	36±4	469

Wherein the definitions are as in Table 3.

It is particularly important that persons who have diets lacking in eggs and milk products wherein fat is replaced with other oils be given products supplemented with α-linolenic acid. Since children who can not drink milk are frequently given supplements with other oils, such as corn oil, it is seen that the addition of α-linolenic acid to such oils is needed to prevent the development of hypercholesterolemia.

Example: Infant Formula

Combine 450 g water and 70 g soybean flour (precooked and dehydrated). Mix thoroughly. Add to the mixture 2 g corn oil and 60 mg α-linolenic acid and blend at high speed. (May be strained through a cloth if the flour is not sufficiently fine.)

Example: Salad Dressing

Combine 500 g corn oil, 30 g flaxseed oil (approximately 50% α-linolenic acid), 200 ml. wine vinegar, 5 g salt, 3 g pepper. Blend thoroughly.

α-linolenic acid can be added to meats and meat sauces during preparation or mixed in just before packaging. α-linolenic acid may also be added to processed meats or ground meat or ground meat products. For example, α-linolenic acid may be added to sausage meat or

frankfurter meat mixture before the meat is placed in the casing. For use in spaghetti sauce, the α-linolenic acid can be added at the time of cooking or just before packaging.

The examples provided herein are not exhaustive, but are merely provided to exemplify the method of enhancing health through balancing of oils and fats using α-linolenic acid.

Claims:

1. A method of enhancing balance of oils and fats which contain at least about 7% saturated fatty acids and at least about 5% linoleic acid by addition of an amount of α-linolenic acid equivalent selected from the group consisting of α-linolenic acid, ethyl linolenate and flaxseed oil to provide a food product wherein the α-linolenic acid content is 1% to 10% of the total fatty acid content of the oil or fat.

2. A method of claim 1 wherein the final product contains a concentration of α-linolenic acid that represents 1.5 - 6% of the total fatty acid content.

3. A method of claim 2 wherein the α-linolenic acid represents about 3% of the total fatty acid content.

4. A method of claim 1 wherein the food product contains corn oil.

5. A method of claim 1 wherein the food product contains safflower oil.

6. A method of claim 1 wherein the food product contains peanut oil.

7. A food product containing at least one oil or fat which naturally contains less than 1% α-linolenic acid to which has been added sufficient α-linolenic acid equivalent to provide that the total lipid fatty acid content is 1% to 6% α-linolenic acid.

8. A product of claim 7 which contains corn oil.

9. A product of claim 7 which contains safflower oil.

10. A product of claim 7 which contains peanut oil.

11. A product of claim 7 which is corn oil with 1.5% to 6% α-linolenic acid.

12. A product of claim 11 which is corn oil with about 3% α-linolenic acid.

13. A product of claim 7 which is safflower oil with 1.5% to 6% α-linolenic acid.

14. A product of claim 13 which is safflower oil with about 3% α-linolenic acid.

15. A product of claim 7 which is peanut oil with about 1.5% to 6% α-linolenic acid.

16. A product of claim 7 which is a processed meat product.

17. A product of claim 7 which is a mayonnaise.

18. A product of claim 7 which is an infant formula.

19. A product of claim 7 which is a salad oil.

20. A method of enhancing balance of oils and fats which contain at least about 7% saturated fatty acids and at least about 5% linoleic acid by addition of an amount of α-linolenic acid equivalent selected from the group consisting of α-linolenic acid, ethyl linolenate soybean oil and flaxseed oil to provide a food product wherein the α-linolenic acid content is 1% to 3.5% of the total fatty acid content of the oil or fat.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :A23D 9/00
US CL :426/601

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/601 426/801,72

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A, 4,948,811 (Spinner) 17 August 1990 See Abstract	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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